# Guidelines for Physics Projects

विद्ययाऽमृतमश्नुते

एन सी ई आर टी
NCERT

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
**National Council of Educational Research and Training**

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# FOREWORD

Projects can make experimental work in physics more creative and enjoyable. They also help students to improve their experimental and communicational skills and to develop scientific attitudes and interests. Recognising the value of projects, the Central Board of Secondary Education has allowed the physics students at the +2 stage to do one project in lieu of three optional experiments. However, since the project concept is new, it was found that teachers face difficulties in guiding students in project work. The present booklet aims to orient teachers in this comparatively new area of physics teaching, and provides guidelines for the execution of projects.

The first draft for this booklet was prepared in a workshop organised by the Council's Department of Education in Science and Mathematics (DESM) at Science Centre No. 3 of the Directorate of Education, New Delhi. This draft was later finalised in another workshop conducted by DESM at the NIE Campus. I am grateful to all the participants of these workshops for the pains taken by them, specially to Dr. R. N. Mathur of DESM, who coordinated this programme. My thanks are also due to Prof. B. Sharan, Head, DESM, and to Dr. R. N. Mathur for finalising the draft and bringing it to its present form.

Suggestions regarding new projects and for the improvement of the present booklet will be most welcome.

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# I. Introduction

## Why Introduce Projects ?

Development of scientific temper is an avowed objective of science education. The science experiments are expected to play a major role in the development of this scientific temper. In scientific tempered students we expect certain competencies.

Development of experimental competencies requires time. The time available for doing experiments is hardly sufficient to develop the competencies. A student who has completed all the prescribed experiments is at the best eligible for a certificate that he is capable of identifying science apparatus that he has seen, making observations and carrying out experimental instructions relating to recording. We expect higher abilities and skills of planning, execution and critical appraisal of experiments performed. The performance of the prescribed experiments in the traditional way except for confirming and establishing faith in some of the statements come across in science textbooks, hardly helps in developing these higher abilities and skills

The two main hurdles, the shortage of time and traditional or confirmatory approach to experiments in the development of scientific temper have been removed by proposing an increased allocation of time and investigatory or project approach. In the Central Board of Secondary Education a project is considered to be equivalent to three optional experiments, in terms of time requiring 15 hours of work.

Some students having keen power of observation or imagination may be struck by some brilliant idea which they may like to try. The idea may pertain to reproduction or fabrication of something seen, a natural phenomenon or a man made device, it may also pertain to designing an apparatus based on imagination, or for investigating interdependence between two or more phenomena.

The projects provide freedom to try out any of the ideas and consequently allow for mental growth The rigid time table and prescriptive approach permit no deviation either in the objectives or in the method They are repulsive for any creative mind. The interest taken and thrill enjoyed in trying new ideas is lost when experiments are just instruction based and performed mechanically Thus through project we expect to promote skills in self initiated learning and communication through planning, execution, self analysis (self appraisal) and reporting The execution may involve, innovations, improvisations, whereas the self analysis or simply analysis—limitation of the project and reliability of the results.

There are two hurdles which are visualised in the implementation of the project programme, (i) the project idea is new and many teachers or teacher educators may find it difficult to provide proper guidance, and (ii) the facilities available in the school. The present booklet provides some examples of projects that could be done within the available resources of schools These are illustrative and not prescriptive Inspite of this, there might be difficulties in making project idea acceptable to all the schools. Keeping this in view, the projects have been made optional and only part of the experimental time has been allocated for the projects

After completion of the project, the students will need some sort of certification, to facilitate this some thought has also been given to the problem—how the projects are to be evaluated. These are given towards the end of the booklet.

# II. The Nature of Project Work

The project work differs from routine class experiments, since it aims at investigating a single theme through a series of related experiments. Projects require some degree of original work so that the pupil may attempt to understand the unknown. Thus the laboratory becomes a mini research laboratory. The pupil is taught not only how to handle modern equipment, if available, and to analyse result, but more important he is encouraged to consult the library, to question, and take initiative in problem solving.

One of the most important padagogic aims of the experimental approach is to bring out the interdependence of the experiment and theory. Since even elegant theories may be approximately true, it is important that the pupil should have a good theoretical background so that he may be able to carry out meaningful scientific investigations. Rather than aiming to verify laws and relationships, projects could be designed to show their limitations. It may be desirable to have modern equipment available but many significant projects could be carried out by using simple and inexpensive equipment. For example, the simple pendulum provides a good introductory project which enables the pupil to investigate how the period of the pendulum changes with various parametres like the length, amplitude and the mass of the bob. This enables the pupil to develop his skills in taking accurate measurements, analysing data and estimating errors. A considerable amount of physics can also be learnt if the project laboratory has modern resources such as multimetres, power supplies, rectifiers, resistors, thermistors etc.

The teacher should suggest to his pupils problems in experimentations which are sufficiently challenging. However they should not be too difficult or too ambitious. The investigation should be carried out by the pupil with occasional help from the teacher.

The teacher could also prepare project sheets, similar to the ones given in Chapter IV containing a general outline of the aims of the investigation and the explicit precautions to avoid damage to a costly piece of equipment or harm to the pupil. A suitable bibliography may also be provided to the student at the planning stage

# III. Proforma for Writing Project Sheets

The suggested proforma is given below.

The intention is to provide guidelines to the pupil so that with some initiative he can develop a project he can do. The outline given in the project sheet is brief and the details can be worked by the pupil either independently or with the help of reference material and in consultation with the teacher.

1. Title of the Project
2. Aims
3. Apparatus needed
4. Outline
5. Precautions
6. Suggestions for improvisation/further scope
7. References

# IV. Sample Project Sheets

The projects described are only suggestive. The teacher may make additions or deletions in the expected work depending on the availability of time, apparatus and extent of improvisation needed. The list of apparatus needed is also suggestive and the use of different apparatus to tryout alternative procedures is encouraged Only major items needed for the experiment are listed. Although a brief outline of the procedure is given, the pupils may be encouraged to take a wide span of observations and arrive at new relationships. Where possible the data obtained may be properly organised and analysed drawing graphs and figures where ever needed.

# PROJECT 1

## Title

Electrical conductivity of solutions.

## Aims

1. To investigate the effect of the following on electrical conductivity of solutions.

   (*a*) Strength of solutions.
   (*b*) Changes in pairs of electrodes.
   (*c*) Changes in temperature of the electrolyte.
   (*d*) Changes in distances between the electrodes.
   (*e*) Changes in size of electrodes.

2. To determine the charge carried by an ion.

## Apparatus Needed

Battery Eliminator (0-12V), milliammeter (0-1000 ma), copper voltameter, variable resistor, one way key, saturated copper sulphate solution, measuring cylinder (500 ml), distilled water, copper and carbon electrodes (2 each).

## Outline

Saturated copper sulphate solution could be taken as an electrolyte. The conductivity of the solution may be measured with a sensitive milliammeter. The electrolyte may then be successively diluted and the conductivity noted at different concentrations. The distance between the electrodes is kept constant throughout the experiment. Similarly, different pairs of electrodes like Cu-Cu, Cu-C etc., could be used and electrical conductivity measured keeping the inter-electrode separation and electrolyte concentration constant. Also by measuring the amount of metal deposited due to a constant current for a known time, the electronic charge could be determined.

**Suggestions for Improvisation etc.**

Different pairs of electrodes from electro-chemical series could be tried.

## REFERENCES

1 National Science Teachers Association (NSTA), *If You Want to do Science Projects*, Washington, D C.

2 National Science Teachers Association (NSTA), *Thousands of Science Projects in Science Service*, Washington, D C.

# PROJECT 2

**Title**

Motion of a simple pendulum in a magnetic field

**Aims**

To investigate the effect of magnetic field on the time period of a simple pendulum.

**Apparatus Needed**

Wooden stand, pendulum bobs (brass and iron) of different mass, stop watch, metre rod, thread, vernier callipers, physical balance, weight box and a strong magnet.

**Outline**

Suspend a pendulum bob and observe the time period. Put this bob in a strong magnetic field and again measure the time period. Note that the field should be uniform and act in the vertical direction on the bob

Change the distance between the poles of the magnet and the bob and again observe the time period. Do you find any change in the time period ?

Change the mass of the bob and again repeat the observations.

Instead of an iron bob take a brass bob and repeat the experiment. Do you find any change in its time period due to magnetic field ? To make the effect stronger more magnets may be used in parallel.

**Precaution**

Magnetic field should be as uniform as possible and it should act in the vertical direction.

**Suggestions for Improvisation etc.**

(i) Try this experiment by applying the field in the horizontal direction.

(ii) One can also use an electromagnet.

### Title

A study of transistor as an amplifier/oscillator.

### Aims

To study the variations in amplification and frequency of oscillation by changing the values of various components used in the circuit.

### Apparatus Needed

Transistor AC 128—one piece, capacitor—0 1μF, 12V six pieces, variable capacitor of suitable values, resistors of 10K, 33K, 49K, 56K (1/2 watt), sound output transformer, speaker—6 cm 8 ohm, tag board, 10 pins, power supply matching for AC 128

### Outline

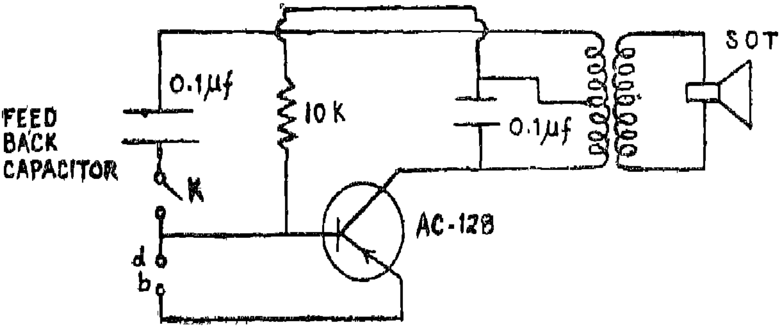


**Fig. 1.** Circuit diagram of transistor working as an audio oscillator/amplifier.

When the switch K is on, the circuit works as an audio oscillator otherwise it works as an audio amplifier. Frequency of the oscillator circuit can be varied by changing the value of feed-back capacitor, base bias resistor, capacitor of the tank circuit and d c voltage between emitter and centre tap of sound out-put transformer.

Use AC 125 in place of AC 128 and try again In case AC 127 is to be used in place of AC 128 the polarity of the battery must be reversed. AC 128 and AC 125 are PNP transistors whereas AC 127 is NPN transistor.

To improve the quality of sound an RC (Resistance and capacitance) combination can be put across the primary of the out-put transformer

## Further Scope

To get feedback one can use one more transistor in place of sound out-put transformer as shown below.

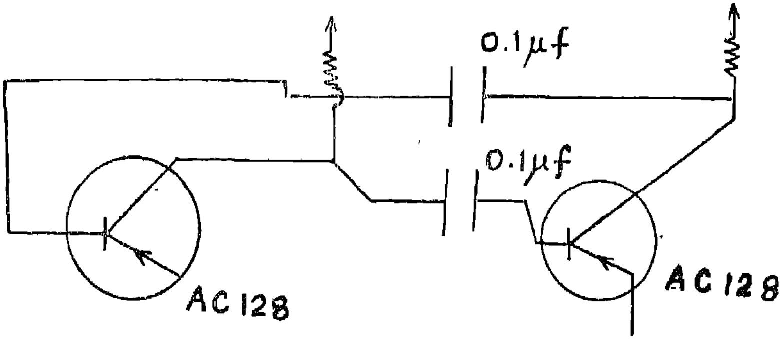


**Fig. 2.** Transistor in feedback circuit.

## REFERENCES

1. Tepper, Marvin, *Basic Radio,* John F. Rider Publisher Inc., New York, 1961.
2. Jacobowitz, Henry, *Electronics Made Simple,* Doubleday and Company, New York, 1965.

## PROJECT 4

### Title

To study the projectile motion.

### Aims

To investigate the relation between

(*a*) height and range.

(*b*) velocity and range.

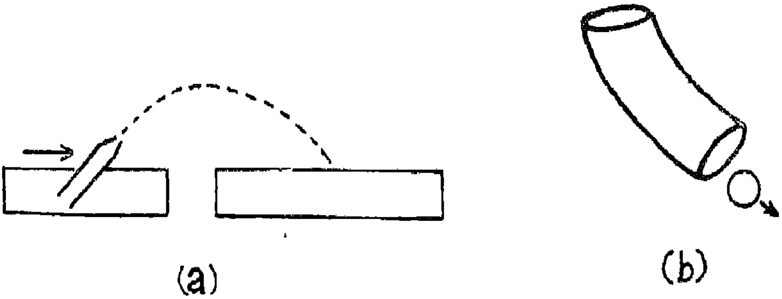
(*c*) angle of projection and range

### Apparatus Needed

Hollow rubber pipes of different diameters, steel balls, metre scale, chalk pieces, carbon papers, white paper sheets, water bath, rubber tubing, pinch cock, glass jet, protractor.

### Outline

This project can be carried out either by using a hollow bent pipe or a vessel having fine holes at different height on lateral side or water issuing out of a jet. The possible arrangements are shown below.



(a)

(b)

Fig. 3. (a) Water jet. (b) Hollow bent pipe.

*(a) Relation between height and range*

The velocity is to be kept constant during this activity which can be achieved by keeping the upper end of the hollow pipe at constant height.

The range is measured for different heights from the ground.

*(b) Relation between velocity and range*

The height of the upper end of the hollow pipe is varied where as the height of other end is kept constant

*(c) Relation between angle of projection and range*

The speed of the projectile and its height from the ground is kept constant during this activity.

## REFERENCES

1 Resnik, Robert and Halliday, David, *Physics*, Wiley Eastern Limited, New Delhi, 1962

2 Sear, W. F , *College Physics*, Addison Wesley Publishing Company Inc., London, 1957.

## PROJECT 5

### Title

To study ripple factor

### Aims

1. To study the ripple factor for half wave rectifier, without any filter.

2 To study the ripple factor for full wave rectifier with .

  (*a*) no filter
  (*b*) capacitor filter.
  (*c*) combination of capacitors as filter.
  (*d*) L—Section filter.
  (*e*) π filter
  (*f*) combination of π filter with more filters.
  (*g*) filters of different specification

### Apparatus Needed

Two diodes (BY 126, BY 127, BY 125) centre tapped transformer (12-0-12V) high resistances, voltmeters and ammeters, multimeter, capacitors.

### Outline

The basic aim of this exercise is to determine the ripple factor experimentally. This is done by observing the a. c and d. c.

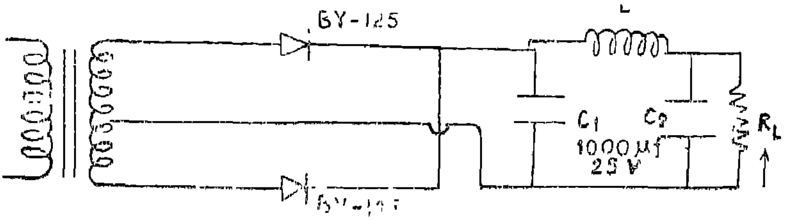


Fig. 4. Circuit diagram of a full wave rectifier with π filter.

current through the load. After this the two values (calculated and experimental) can be compared If there is a disparity between the two values, one should try to explain for same.

## Precaution

Load should be quite high, so that the measuring instruments are not damaged

## REFERENCES

1. Seely, Samuel, *Electron Tube Circuits*, McGraw Hill Book Company Inc., New York, 1958.
2. Ryder, J. D , *Engineering Electronics*, McGraw Hill Book Company Inc., New York, 1967.

## PROJECT 6

### Title

Study of V-I characteristics beyond metals.

### Aims

To study V-I characteristics of different materials (wet cotton thread, wet wood, pencil leads of different grades, wet chalk pieces etc )

### Apparatus Needed

A multimeter with three ranges for resistance measurement, voltmeters 0-10 volts d c. and 0-100 volts d c, power supply 0-300 volts d c milliammeter, micrometer or travelling microscope for finding diameters etc., material under observation.

### Outline

Different current passes through the test material with different potential differences. Both a.c. and d.c types of sources can be tried out. Experiments can be tried to study the laws of resistances with the given materials. The limitations of the Ohms law may also be studied.

Different lengths of pencil lead and different grades can also be tried. These could also serve as different low resistance materials.

# PROJECT 7

## Title

A study of behaviour of various vacuum tubes used as diode and triode.

## Aims

1. To study valve characteristics of a triode as a diode keeping
   - (*a*) grid open
   - (*b*) grid shorted with cathode
   - (*c*) grid shorted with plate.
2. To study pentode and heptode as diode and triode by shorting various grids
3. To compare the amplification factor/value of valve resistance in above cases.

## Apparatus Needed

Triode valve (635), pentode (EF-89), heptode, power supply (0-300 V), milliammeter (0-100 ma).

## Outline

This project is to study the effect of inter plate separation and plate area on plate current of the diode. To see this the triode is treated like a diode In the first case the grid is left open and diode current is measured against plate voltage. The curves can be drawn for various filament currents. The same procedure is repeated twice by shorting grid with cathode and plate respectively. By doing so the triode has been converted into a diode but the effective separation between the cathode and the anode and the plate area is different in different cases. By simultaneously studying these graphs the effect of inter plate separation and plate area can be determined The same experiment can be repeated with pentode and heptode In the case of pentode the variation of amplification factor can also be studied There the pentode is to be used as a triode, once by keeping the screen open and then by shorting the screen with plate (as an additional activity). Here the variation of valve resistance with inter plate separation can be studied.

## Precautions

1 When grid is shorted with plate, voltage of the plate should be kept very low.
2. While using pentode, suppresser must be earthed

## REFERENCES

1 Seely, Samuel, *Electron Tube Circuits,* McGraw Hill Book Company Inc., London, New York, 1958

2. Ryder, J. D., *Engineering Electronics,* McGraw Hill Book Company Inc , London, New York, 1967.

3. Jacobowitz, Henry, *Electronics Made Simple,* Doubleday and Company, New York, 1965.

# PROJECT 8

## Title

To investigate the variation of resistance of a semiconductor diode with intensity of light/wavelength of light/temperature and also to construct a Burgler Alarm (semiconductor thermometer)

## Aims

1. To acquaint the students with factors influencing the resistance of a semiconductor diode (in reverse biasing)
2. To make use of a diode in different electronic circuits used in daily life.

## Apparatus Needed

Photodiode diode (OA-79), bulb, convex lens, multimeter, soldering iron, condenser, resistance, solder wire, connection wires, microammeter (0-50 $\mu$a).

## Outline

To study the effect of intensity of light on the resistance of a semiconductor diode, allow the light from the bulb to be incident on a photodiode. Note the resistance of the diode with a multimeter for different distances of the source of light from photodiode Inverse square law of light can be verified easily with this arrangement.

To study the effect of wavelength of light on the resistance of a diode, obtain a parallel beam of light by placing a convex lens in front of the source Using filters of different colours variation in the resistance of a photodiode with different colours of light can be studied.

To study the effect of temperature, place the diode (OA-79) in an oil bath. Heat the oil bath and note the change in resistance of the diode (reversed biased) with temperature Assemble an electronic circuit for a thief alarm, automatic counter etc., using the above mentioned properties of a photodiode A semiconductor thermometer can also be constructed using OA-79 diode

## Precautions

1. The temperature of the diode should be changed by placing it in an oil bath It should not be heated directly
2. While measuring resistance, diode should be reverse biased.

## Suggestions for Improvisation

In case of non availability of good filters, one can use cellophene coloured papers as colour filters.

In case of non availability of a multimeter, one can use milliammeter and ordinary voltmeter available in schools

*Note*. Reverse current is only of the order of few microamperes.

## REFERENCES

1 Tepper, Marvin, *Basic Radio* (Volume 5), John F. Rider Publishing Inc., New York, 1961.

2. Fountaine, Guy, *Diodes and Transistors*, Cleaver Hume Press Ltd., London, 1963.

# PROJECT 9

## Title

Energy conservation.

## Aims

To investigate the energy conservation in the case of a pendulum.

## Apparatus Needed

Iron stand, razor blade, pendulum bob (about 100-200 g), metre rod, carbon paper, protractor (large size), thread, vernier callipers, physical balance and weight box

## Outline

Pull the pendulum bob to one side and measure the height of the bob at this point (P.E.$=mgh$). Note that the bob has no K.E. at this point.

To find the K. E. of the bob when it passes through the lowest point of the swing, it is essential to measure the velocity of the bob at this point. To do this the bob should be separated from the string as it passes through its lowest point (at this point P.E. is zero). The bob is then in free fall and will land on the floor some distance from the point of separation. By measuring the horizontal displacement of the bob from the point of separation and the time of fall, can we calculate the velocity of the bob at the point of separation ? Note that to calculate the time it is essential to measure the vertical distance through which the bob falls.

Similarly calculate the K. E. and P. E. of the bob at some intermediate point.

See if the mechanical energy is conserved in this investigation.

Study some other system of energy change and try to explain them in terms of the principle of conservation of energy (i e., bouncing ball, water fall, oscillating ball in a curved tube) as below

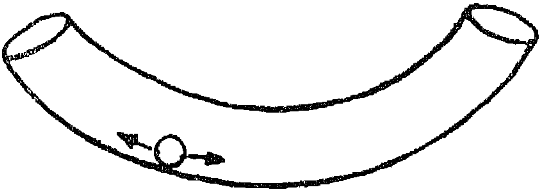


Fig. 5. A ball oscillating in a bent tube.

**Suggestions for Improvisation**

(i) Instead of using a razor blade an electromagnet can be used to release the bob.

(ii) A protractor can be lined with the thread to measure the angle.

REFERENCE

Jardine, Jim, *Physics is Fun*, Longmans, London, 1966.

# V. Guidelines for Writing Project Report

In project work effort is made to help pupils develop some of the skills needed to write a scientific report. It is, therefore, suggested that the project report may contain the following.

1. Title of the Project
2. Background Knowledge
3. Objectives of the Project
4. Procedure (with diagrams, if any)
5. Precautions
6. Data and Data Reduction
7. Data Analysis (Graphs etc.)
8. Results
9. Discussion (including errors in the experiment, limitations, scope for further work)
10. Acknowledgements
11. Bibliography/References

# VI. Evaluation of Projects

Through projects we have intended to develop some specific abilities and skills The evaluation should therefore be able to indicate to what extent one has succeeded in acquiring these abilities and skills, in other words, the desired abilities and skills should form an important part of evaluation

The abilities and skills intended to be developed through project work that have been identified are planning, execution and appraisal

The planning here is visualised to be the ability to conceive the total plan of the project which may include ·

—problem identification

—problem formulation

—procedure intended to be adopted for solving the problem

—requirements

The execution is visualised to consist of

—data collection from literature or through observations by actually performing experiments

—apparatus fabrication or improvisation

—apparatus setting

—apparatus handling and care

—experimental skills

—data analysis

—data interpretation

—drawing of inferences and conclusions (Results)

In appraisal it is visualised that the students would discuss points relating to reliability of results in terms of

—errors in experiments

—limitations of experiments

—scope for improvisations

The evaluation of the different abilities—planning, execution and appraisal is to be a step by step process. Before starting the project the students should be required to present a written outline plan or synopsis of the project. The teacher/supervisor is expected to examine the plan submitted from the point of view of its feasibility and suggest modifications where necessary. The examination of the plan or synopsis from the feasibility point is the first step in evaluation.

With the execution part are clubbed two components, performance and analysis. In the evaluation of the performance part the teacher/supervisor is expected to minutely watch the setting of the apparatus, handling of the apparatus and accuracy of some key (important) observations The watching of key points by the supervisor is the second step in evaluation, it requires watching while the student is actually executing the project or performing the experiment. The supervisor may specifically note any original or creative effort of the student, reflected in fabrication or improvisation of apparatus. The supervisor may note whether the student is careful or casual (careless) in setting and taking observations. Any attempt to cook or manipulate the observation should be punished severely and accordingly given no credit.

In the evaluation of the second component of execution i.e., analysis, the supervisor should specially note if the student has shown any novelty or newness in techniques used in analysis, drawing inferences or conclusions. The evaluation of the analysis or the second component of execution is to be based on the written report submitted by the student. This is the third step in evaluation.

In the evaluation of the appraisal part supervisor should pay special attention to the discussion of errors, limitations and scope for improvisation of experiments. This is the fourth step in evaluation. This also is to be based on the written report submitted by the student.

The supervisor in addition may like to examine the report from the point of view of presentation (tabulation, sequencing) and communication i.e., clarity and preciseness of the language

After evaluation, for certification it is necessary to grade (or mark) the students. It is prefeired to use a five point scale for grading instead of marks. The five grades scale be F, C, B, A and E denoting poor, potential (promising), good, very good and excellent respectively. In this classification poor is a fail and all others are pass.

Each grade here represents acquisition of specific abilities.

The grade F means, the student has neither the ability of planning nor execution. The observations or results or both submitted may not be trustworthy, they might have been cooked or manipulated

The grade C is intended to mean that the student has exhibited the ability of proper planning and execution of the project. This is the minimum we expect in a student whom we consider to be potential or promising and therefore deserves to pass or to be promoted This is presumed to be equivalent or mean III Division awarded in some of the State Board Examinations.

The grade B is intended to mean that the student has exhibited the ability of proper planning, execution and critical appraisal. The student here has exhibited an additional and higher ability i e., appraisal and therefore deserves to be awarded a higher grade i e , average or B in the proposed symbology. Since all the essential abilities are exhibited here in a potential form. So we call it good. It is presumed to be near II Division awarded in the State Board Examinations.

The grade A is intended to mean that the student has not only exhibited the ability of proper planning, execution and critical appraisal but also shown higher abilities of either originality/creativity reflected in fabrication/improvisation or critical power of observation and analysis. In our terminology, the student is therefore very good. It is presumed to be near I Division awarded in the State Board Examination.

The grade E is intended to mean that the student has exhibited superb performance in planning, execution, appraisal, originality, in fabrication/improvisation and critical power of observation and analysis, communication and presentation and therefore is excellent. The student may miss this grade if any of the above mentioned qualities are missing. The Evaluation Form given in Appendix I may be used for complete evaluation.

In evaluation, one may like to mention separately about the presentation and communication abilities, they do not strictly relate to abilities expected of students doing projects.

## APPENDIX I

# Evaluation Form

| | *Criteria* | *Remarks* |
|---|---|---|
| 1 | Planning | Approved/Modified |
| 2 | Execution | |
| | (a) Performance (setting & observations) | Satisfactory (careful/casual/manipulated careless/cooked) |
| | (b) Analysis (inferences & conclusions) | Use of new technique/ routine (new/routine/ manipulated or cooked) |
| 3 | Appraisal (errors, limitations and improvisations) | Equipment or apparatus |
| 4 | Creativity | Fabricated/improvised/used what was available |
| 5. | Presentation (sequencing and communication) | orderly/haphazard comprehensive, precise and clear/slipshod |

**Grades :** F. if setting and observations manipulated

C. if planning approved/modified and performance satisfactory.

B. if planning approved/modified performance satisfactory and appraisal is critical.

A. if planning approved/modified execution satisfactory, appraisal critical and creativity exhibited

E. if all quantities of A present plus critical power of observation and analysis exhibited in, other words, the student is excellent in every respect Communicational skill stated as above.

*Note* The improvements affected after suggested modifications are to be considered only while awarding 'excellent' grade, or where the teacher is convinced that the student lacks initiative i e., does not do anything completely by himself. The purpose is not to discourage discussions between teacher and students

## APPENDIX II

# List of Participants and Resource Persons

## WORKSHOP TO SELECT AND TRY OUT PHYSICS PROJECTS

*(Held at the Science Centre No 3, Directorate of Education, New Delhi)*

1 Shri B N Mehrotra
Senior Science Councellor
Directorate of Education
Science Centre No 3
Link Road, Karol Bagh
New Delhi

2. Sh C M Srivastava
Senior Science Councellor
Directorate of Education
Science Centre No. 3
Link Road, Karol Bagh
New Delhi

3. Shri B S. Tanwar
Senior Science Councellor
Directorate of Education
Science Centre No 3
Link Road, Karol Bagh
New Delhi

4. Shri C B Verma
P G. T (Electronics)
D C Arya Higher Secondary School
Lodhi Road
New Delhi

5 Mr. Ajay Deepak
P G T
Kendriya Vidyalaya
Tagore Garden
New Delhi

6 Mr Subash Singhal
P G T.
Modern School
New Delhi

7. Shri S. K Vasil
P G T
Govt Girls' Senior Secondary School
Andrews Ganj, New Delhi

8 Shri Kanhiya Lal
Directorate of Education
T V Branch
Defence Colony, New Delhi

9 Dr B Sharan
Professor and Head
Department of Education in Science and Mathematics
NCERT, New Delhi

10 Dr S G. Gangoli
Reader
Department of Education in Science
and Mathematics
NCERT, New Delhi

11 Dr. R N Mathur (Coordinator
Reader
Department of Education in
Science and Mathematics
NCERT, New Delhi

## WORKSHOP TO FINALISE THE GUIDELINES FOR PHYSICS PROJECTS

*(Held at DESM, NCERT, New Delhi)*

1. Dr O N Awasthi
Lecturer
Regional College of Education
Mysore

2. Shri S B Singh
Reader
Regional College of Education
Ajmer

3 Dr. K. V. Reddy
Department of Physics
Indian Institute of Technolgy
Madras

4. Shri B. G Pitre
P G T
Doon School
Dehra Dun

5. Shri P. D Pande
P G T
Netrahart School
Netrahart (via Ranchi)
Bihar

6. Shri G. K. Kapoor
P. G. T.
Scindia School
Gwalior Fort
Madhaya Pradesh-474008

7 Dr. Alok Chakrabarti
Department of Physics
S A. Jaipuria College
6-C Nalin Sarker
Calcutta-700004

8. Shri A V. Jafri, Coordinator
Creative Teaching Unit
Department of Physics
Aligarh Muslim University
Aligarh

9 Shri H. Sharma
Govt Girls Hr Sec School
Dayanand Road
Daryaganj, New Delhi

10 Shri P. C. Chhabra
P G. T
Delhi Public School
Post Box No 471
Mathura Road
New Delhi-110011

11 Shri C. M Srivastava
Senior Science Councellor
Science Branch
Directorate of Education
Link Road, Karol Bagh
New Delhi

12 Shri Suraj Prakash
P G T
Nav Yug School
Sarojini Nagar
New Delhi

13 Shri R K Marwaha
P G T.
Raj Kumar College
Rajkot

14 Shri H P. Chhaya
Principal
Bhartiya Vidya Bhavan
Curzon Road
New Delhi

15. Dr S K Monga
Lecturer
Hans Raj College
Delhi University Campus
Delhi

16 S K Agnihotri, Lecturer
Central Institute of Education
Chhatra Marg
Delhi University, Delhi

17 Shri P R. Verma
P G. T.
Kendriya Vidyalaya
Hindon-201004 (U P.)

18 Prof B Sharan, Head
DESM, NCERT
New Delhi-110016

19 Dr S. G Gangoli
Reader
DESM, NCERT
New Delhi-110016

20. Dr R N. Mathur (Coordinator)
Reader
DESM, NCERT
New Delhi-110016